Missouri Department of Natural Resources
Water Protection Program

Bacteria
Total Maximum Daily Load (TMDL)

for

Fishpot Creek
St. Louis County, Missouri

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Total Maximum Daily Load (TMDL) for Fishpot Creek
Pollutant: *Escherichia coli*

Name:
Fishpot Creek


State Map Showing Location of Watershed

Location:
St. Louis County

Nearby City:
Ballwin

12-digit Hydrologic Unit Code (HUC):
071401021002, Grand Glaize Creek-Meramec River

Water Body Identification Number (WBID) and Hydrologic Class:[1]
WBID 2186 – Class P

Designated uses:[2]
Livestock and wildlife protection (LWP)
Protection of warm water habitat (WWH)
Human health protection (HHP)
Whole body contact recreation category B (WBC-B)

Other designations:
Metropolitan no-discharge stream[3]

Use that is Impaired:
Whole body contact recreation category B (WBC-B)

Length and location of impaired segment:[4]
3.5 miles, from mouth to Section 13, Township 44N, Range 4E.

Universal Transverse Mercator [Zone 15 north] coordinates:
E: 718147, N: 4269479 to E: 715609, N: 4270765

Pollutant on 2012 303(d) List:
Escherichia coli, or E. coli, bacteria

[1] For hydrologic classes see 10 CSR 20-7.031(1)(F). Class P streams maintain flow during drought conditions. Class C streams may cease flow during dry periods, but maintain permanent pools that support aquatic life. Class E streams have ephemeral surface flow.
[2] For designated uses see 10 CSR 20-7.031(1)(C) and 10 CSR 20-7.031 Table H.
[3] For metropolitan no-discharge stream designations, see 10 CSR 20-7.031, Table F.
[4] The water body segment length was revised in 10 CSR 20-7.031 Table H, effective October 2009. This revision reflects a more accurate measurement of length. The location and the starting and ending points of this segment have not changed. This length differs from what is presented on the 2012 303(d) list of impaired waters.

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1. Introduction

The Missouri Department of Natural Resources in accordance with Section 303(d) of the federal Clean Water Act is establishing this Fishpot Creek Total Maximum Daily Load, or TMDL. This water quality-limited segment in St. Louis County is included on Missouri's 2012 303(d) List of impaired waters. The listing of Fishpot Creek as impaired by *Escherichia coli* bacteria was approved by the U.S. Environmental Protection Agency on July 11, 2012. The department's 303(d) submittal to EPA cited urban runoff and storm sewers as likely sources of the impairment. This report addresses the Fishpot Creek bacteria impairment by establishing a TMDL for *Escherichia coli*, or *E. coli*. Data analyses conducted to support this listing and TMDL development indicate that *E. coli* bacteria are present at concentrations that result in exceedances of Missouri's water quality criterion for the whole body contact recreation category B designated use.

Section 303(d) of the federal Clean Water Act and Chapter 40 of the Code of Federal Regulations (CFR) Part 130 requires states to develop TMDLs for waters not meeting designated uses. The TMDL process quantitatively assesses the impairment factors so that states can establish water quality-based controls to reduce pollution and restore and protect the quality of their water resources. The purpose of a TMDL is to determine the pollutant loading a water body can assimilate without exceeding state water quality standards. Missouri's Water Quality Standards at 10 CSR 20-7.031 consist of three components: designated uses, water quality criteria to protect those uses and an antidegradation policy. The TMDL establishes the pollutant loading capacity necessary to meet the water quality standards established for each water body based on the relationship between pollutant sources and instream water quality conditions. A TMDL consists of a wasteload allocation, a load allocation, and a margin of safety. The wasteload allocation is the fraction of the total pollutant load apportioned to point sources. The load allocation is the fraction of the total pollutant load apportioned to nonpoint sources. The margin of safety is a percentage of the TMDL that accounts for any uncertainty associated with the model assumptions as well as any data inadequacies.

Fishpot Creek was first listed as impaired by bacteria in 2008 due to data showing elevated *E. coli* concentrations. The state's 2012 listing methodology determines a water to be impaired by bacteria if the geometric mean in a given recreational season exceeds the water quality criteria in any of the last three years for which there are available data. This listing methodology also states that at least five samples are needed during the recreational season in order to determine impairment. The state's recreational season is defined as being the seven-month period from April 1 through October 31. Data meeting the 2012 assessment protocol have been collected and do show Fishpot Creek as being impaired by bacteria.

In addition to bacteria, Fishpot Creek is also included on the 2012 303(d) List as impaired by chloride. The department will develop a separate TMDL to address this condition at a future date. The department maintains its TMDL development schedule online at dnr.mo.gov/env/wpp/tmdl/wpc-tmdl-progress.htm.

2. Background

Fishpot Creek is an urban stream located in eastern Missouri in south-central St. Louis County. The lowermost 3.5 miles of stream is identified in the Missouri Use Designation Dataset as water body

identification number, or WBID, 2186, and is the segment listed as impaired for bacteria.[5] The headwaters of Fishpot Creek originate in Ellisville near the intersection of State Highway 340 and Field Avenue from which it flows for approximately 9.5 miles to the Meramec River (Figure 1). Near Sulphur Springs Court, Fishpot Creek loses at least 30 percent of its flow to the subsurface and remains a losing stream for approximately 1.9 miles until it becomes a gaining stream again at the impaired segment. The Fishpot Creek watershed drains approximately 10.73 square miles and is located in the Meramec Ecological Drainage Unit[6], or EDU, in the Ozark aquatic subregion[7] (MoRAP 2005a).

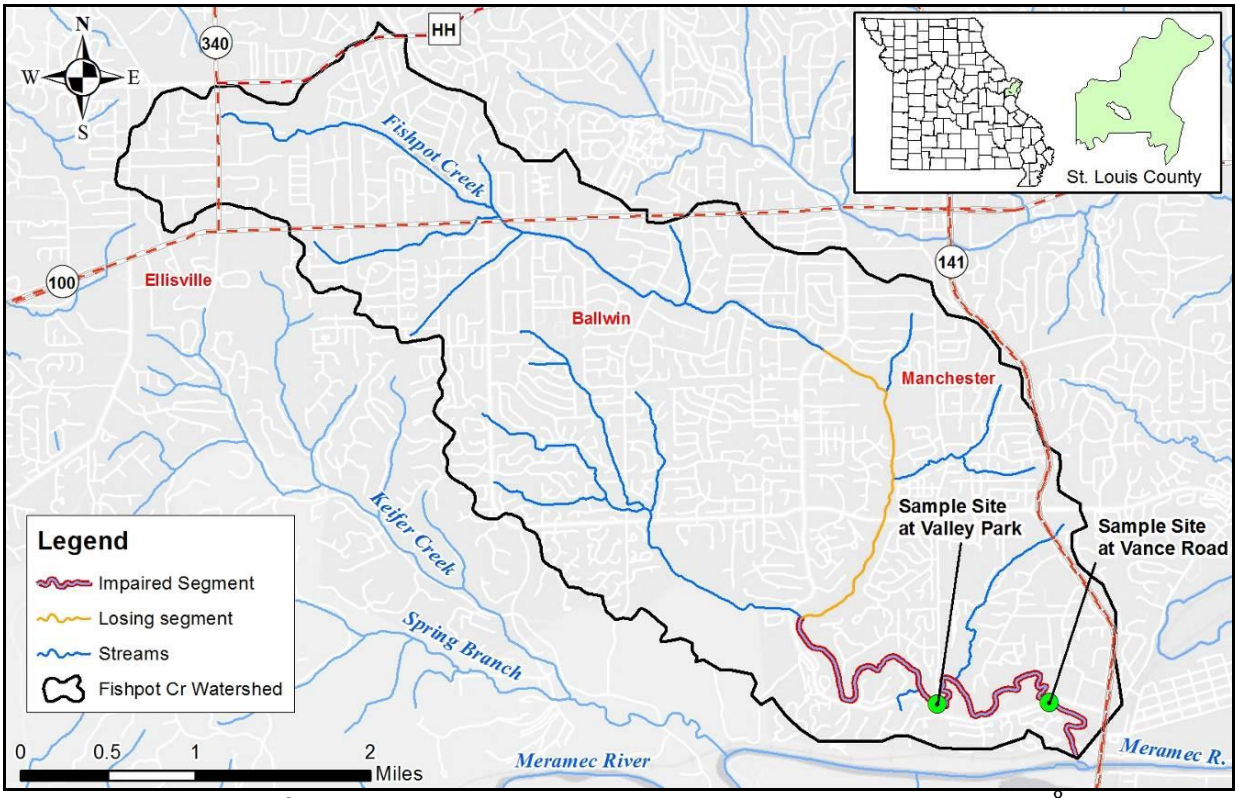

Figure 1. Location of the Fishpot Creek watershed in St. Louis County, Missouri[8]

2.1 Geology, Physiography and Soils

Fishpot Creek is located within the Meramec subbasin, identified by the 8-digit hydrologic unit code, [9] or HUC, 07140102. This subbasin contains portions of the Eastern Ozark Border, Meramec River Hills, River Hills, and Central Plateau level IV ecoregions.[10] The Fishpot Creek watershed is contained within both the River Hills and the Eastern Ozark Border ecoregions, with 60 percent of

[5] The Missouri Use Designation Dataset documents the names and locations of the state's rivers, streams, lakes and reservoirs, which have been assigned designated uses. See 10 CSR 20.7031 (1)(P).
[6] Ecological Drainage Units are groups of watersheds having generally similar biota, geography, and climatic characteristics (USGS 2009).
[7] Missouri's three aquatic subregions are the Central Plains, the Mississippi Alluvial Basin, and the Ozark (MoRAP 2005a).
[8] Sampling sites (downstream to upstream): Site No. 2186/0.6 – Fishpot Creek at Vance Road and Site No. 2186/1.7 – Fishpot Creek at Valley Park (USGS stream gage 07019120).
[9] Watersheds are delineated by the U.S. Geological Survey using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS and NRCS 2011).
[10] Ecoregions are areas with similar ecosystems and environmental resources. A level I ecoregion is a coarse, broad category, while a level IV is a more defined grouping.

the watershed in the former and 40 percent in the latter. The River Hills ecoregion is a transition zone between the Central Irregular Plains and the Ozark Highlands. Key characteristics of the River Hills are loess-covered hills and numerous karst features (Chapman et al. 2002). Appletone Spring located on a tributary of Fishpot Creek is located within the River Hills portion of the watershed. The Eastern Ozark Border ecoregion is a transitional region between the River Hills and the Ozark Highlands. Key features of the Eastern Ozark Border ecoregion are moderately dissected hills, sheer bluffs, and rocky soils. Karst features are also common in this area. In the Fishpot Creek watershed, there are two springs and one sinkhole within the Eastern Ozark Border. Pettys Spring and Bright Spring are both located on the impaired segment and Miller Sinkhole is located about 0.7 miles upstream of WBID 2186. In addition to the springs and sinkhole, there are also five losing streams in the watershed that flow through both the River Hills and Eastern Ozark Border ecoregion areas.

As noted previously, the impaired portion of Fishpot Creek has a stream length of 3.5 miles. The topographic relief along this segment is generally 55 feet along the stream valley up to 246 feet in the adjoining uplands. The elevation of WBID 2186 ranges from approximately 449 feet above sea level (upstream) to 393 feet (downstream). The elevation of the entire Fishpot Creek watershed ranges from approximately 748 feet (upstream) to 393 feet (downstream) (CARES 2005).

Soils in the Fishpot Creek watershed are varied, but can be grouped based on similar characteristics. Table 1 provides a summary of hydrologic soil groups in the Fishpot Creek watershed. Hydrologic soil groups categorize soils by their runoff potential. A soil's hydrologic soil group relates to the rate at which water enters the soil profile under thoroughly wetted, bare soil surface conditions. Group A represents soils with the highest rate of infiltration and the lowest runoff potential under these conditions and Group D represents soils with the lowest rate of infiltration and highest potential for runoff. The dominant soil group in the Fishpot Creek watershed is Group D, which covers approximately 84 percent of the watershed. In general, soils within this group have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. Soils within the second most represented group, Group B, cover approximately 8 percent of the watershed. Group B soils include silt loam and loam that have moderate infiltration rates and are well-drained soils with moderately fine to moderately coarse textures. All other rated soils in the watershed belong to Group C, which covers approximately 4 percent of the watershed. Group C includes sandy clay loam soils that have a moderately fine to fine structure. These soils consist chiefly of soils with a layer that impedes downward movement of water (NRCS 2007). The remaining 4 percent of the watershed area contains soils that are not rated. Areas not rated are typically areas of open water, quarries or landfills. In the Fishpot Creek watershed, areas not rated in a hydrologic soil group are classified as being either water or of the soil type Urban land, upland, 0 to 5 percent slopes. This soil type is classified as being 90 percent urban land and has no specific associated soil data given (NRCS 2010). Figure 2 shows the location and distribution of these hydrologic soil groups throughout the watershed.

Table 1. Hydrologic soil groups in the Fishpot Creek watershed (NRCS 2009)

Hydrologic Soil Group	*Group A*	*Group B*	*Group C*	*Group D*	*Not Rated*
Square Miles	0	0.86	0.43	9.02	0.41
Percentage	0 %	8.1 %	4.0 %	84.1 %	3.8 %

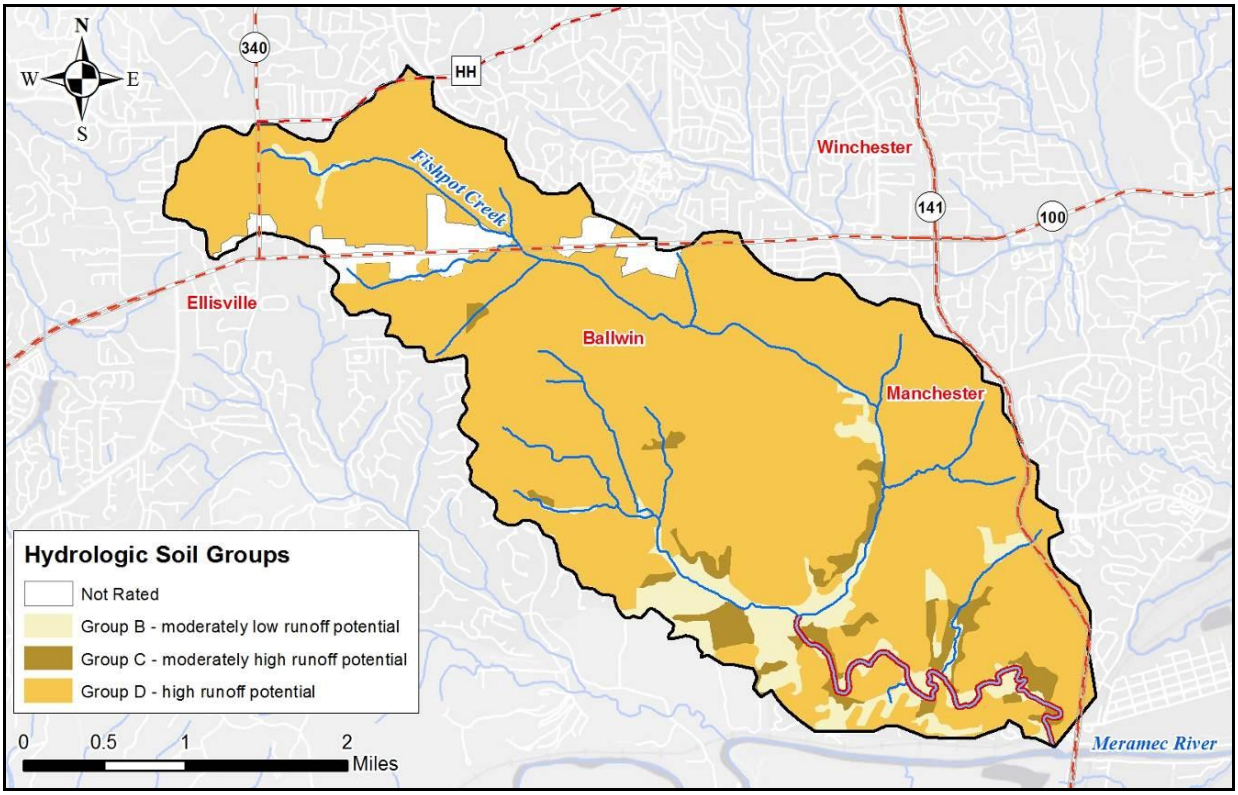

Figure 2. Hydrologic soil groups in the Fishpot Creek watershed (NRCS 2009)

The hydrologic soil groups within the Fishpot Creek watershed are comprised of 24 individual soil types. The five most abundant soil types found in the Fishpot Creek watershed all have a large urban land component (Table 2). Together, these five soil types cover approximately 84 percent of the Fishpot Creek watershed.

Table 2. Abundant soil types in the Fishpot Creek watershed (NRCS 2009)

Soil Type	*Square Miles*	*Percent of Watershed*	*Percent Urban*
Urban land-Harvester complex, 2 to 9 percent slopes	4.29	40.0 %	50 %
Urban land-Harvester complex, 9 to 20 percent slopes	2.69	25.0 %	55 %
Urban land-Goss complex, 9 to 20 percent slopes	0.93	8.6 %	50 %
Fishpot-Urban land complex, 0 to 5 percent slopes, rarely flooded	0.71	6.6 %	50 %
Urban land, upland, 0 to 5 percent slopes	0.41	3.8 %	90 %

2.2 Rainfall and Climate

Weather stations provide useful information for developing a general understanding of climatic conditions in the watershed. The St. Louis Science Center and the Weldon Springs weather stations are the closest sources to the Fishpot Creek watershed with recent and available weather and climate data. Both of these stations are expected to provide climate data that are representative of the impaired watershed. The St. Louis Science Center weather station is located in St. Louis approximately 15 miles northeast of the impaired segment and the Weldon Springs weather station is located in St. Charles County approximately 13 miles northwest of the impaired segment. Both of these stations record daily precipitation, maximum and minimum temperatures, snowfall and snow depth data. The locations of these weather stations in relation to the Fishpot Creek watershed are shown in Figure 3.

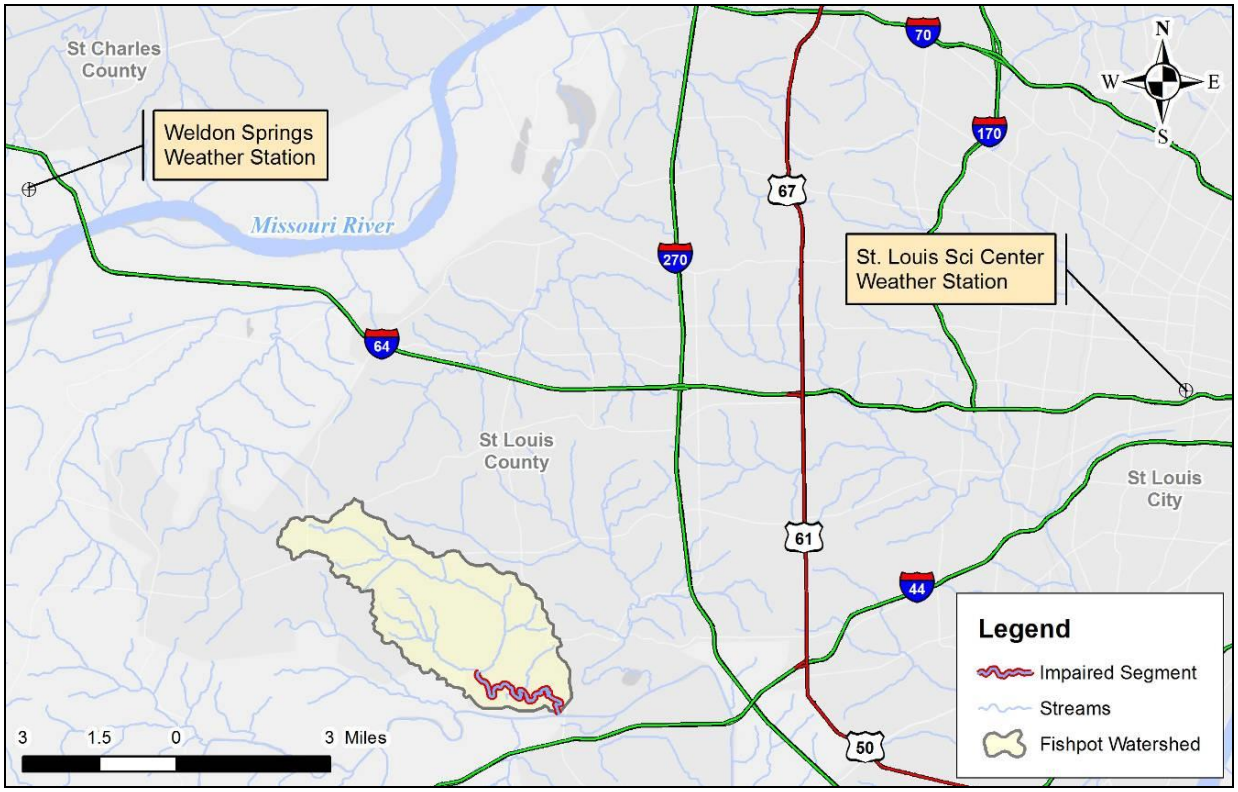

Figure 3. Location of weather stations in relation to the Fishpot Creek watershed

Precipitation is an important factor related to stream flow and stormwater runoff events that can influence certain pollutant sources. The average annual precipitation and annual average minimum and maximum temperatures over the 30-year period from 1981 through 2010 are 41.3 inches and 48.1/66.3 degrees Fahrenheit (°F) for the St. Louis Science Center and 42.5 inches and 43.5/65.5 °F for the Weldon Springs weather station (NOAA 2011). The 30-year climate data from these weather stations are summarized in Figure 4.

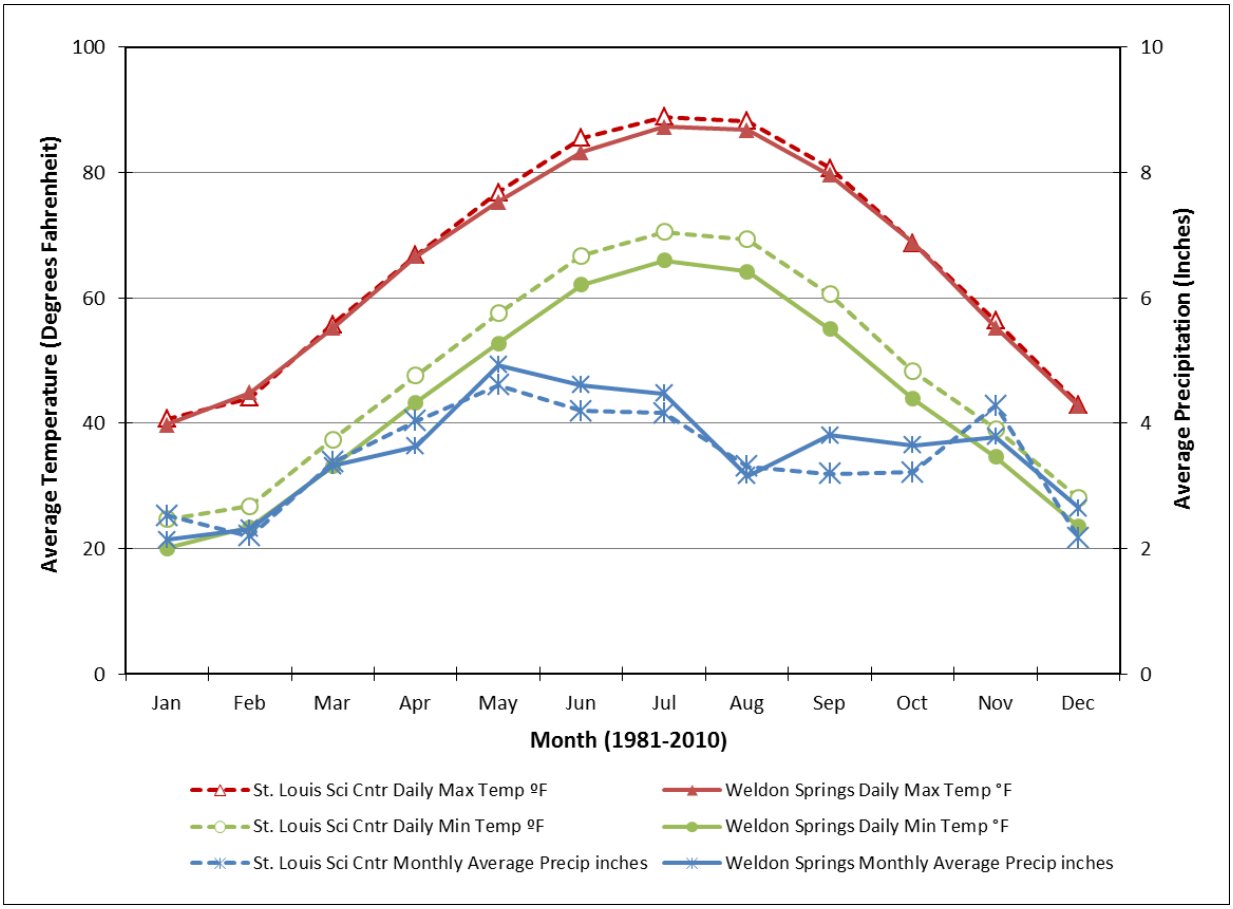

Figure 4. Thirty-year monthly temperature and precipitation averages for the St. Louis Science Center and the Weldon Springs weather stations.

2.3 Population

St. Louis County covers an area of 523 square miles and, according to 2010 census data, has a population of 999,021 people (U.S. Census Bureau 2010). The population of the Fishpot Creek watershed is not directly available; however, using U.S. Census Bureau census block data from 2010, the population of the Fishpot Creek watershed was estimated to be approximately 38,752. The U.S. Census Bureau categorizes the entire Fishpot Creek watershed as an urban area.[11] EPA defines this urban area as an entity requiring stormwater regulations through municipal separate storm sewer permits (EPA 2002).

This population estimation was completed by using Geographic Information System, or GIS, software and superimposing the watershed boundary over a map of census blocks. Wherever the centroid of a census block fell within the watershed boundary, the total population of the census block was included in the total. If the centroid of the census block was outside the watershed boundary, then the population was excluded.

Using 2000 census data and 12-digit hydrologic unit code watershed boundaries, EPA completed a similar analysis and determined that the Fishpot Creek watershed is an Environmental Justice

[11] An urban area is calculated by the U.S. Census Bureau to determine the boundaries of the country's most developed and densely populated areas (http://www.census.gov/geo/www/ua/ua_2k.html).

watershed.[12] This determination was based on the area of the 12-digit watershed and the percentages of racial minority and low-income populations (Steve Schaff, EPA, email communication, June 30, 2011). Communities within an Environmental Justice watershed may qualify for financial and strategic assistance for addressing environmental and public health issues (EPA 2011a).

2.4 Land Use

Land use calculations are based on data from 2000 to 2004 at 30-meter resolution obtained from Thematic Mapper imagery (MoRAP 2005b). These calculations are presented in Table 3. Figure 5 graphically presents the available land use data for the Fishpot Creek watershed. The watershed is predominantly an urban environment, with areas categorized as urban or impervious accounting for over 70 percent of the watershed. Areas defined in the land use dataset as low-intensity urban comprise approximately 64.5 percent of the total area and account for the majority of the watershed's land use. Low-intensity urban is defined as being vegetated urban environments with a low density of buildings. In the Fishpot Creek watershed, these areas are primarily residential areas. Areas categorized as high-intensity urban account for 0.55 percent of the watershed area and are defined as vegetated urban environments with a high density of buildings. Areas of the watershed categorized as impervious account for 5.51 percent of the watershed area. Impervious areas are defined in the land use dataset as being areas with little, if any, vegetation, that are dominated by streets, parking lots, and buildings. Although the land use dataset categorizes specific areas as impervious, impervious areas exist in all urban land use categories due to the presence of roads, parking lots, driveways, and rooftops. The Metropolitan St. Louis Sewer District, which is a public agency responsible for management of wastewater and some stormwater in the watershed, estimates the total imperviousness of the watershed to be approximately 30 percent (Kristol Whatley, Metropolitan St. Louis Sewer District, email communication, Aug. 10, 2012). This amount of imperviousness in the watershed is significant as stream degradation associated with imperviousness has been shown to first occur at about 10 percent imperviousness and to increase in severity as imperviousness increases (Arnold and Gibbons 1996; Schueler 1994).

Following low-intensity urban, the second most abundant land use type in the Fishpot Creek watershed is Forest and Woodland, which comprises approximately 14.6 percent of the watershed. Grassland is the next abundant land use type accounting for over 13 percent of the watershed area. Because of the urban nature of the watershed, areas classified as grassland may include golf courses, cemeteries, parks, school playgrounds and other urban green spaces. The sum of the remaining five land use categories featured in Table 3 account for less than 1.5 percent of the entire watershed area.

[12] EPA defines Environmental Justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies.

Table 3. Land use in the Fishpot Creek watershed

Land Use Type	*Acres*	*Sq. Miles*	*Percentage*
Impervious	378	0.59	5.51 %
High-Intensity Urban	38	0.06	0.55 %
Low-Intensity Urban	4,426	6.92	64.48 %
Row and Close-grown Crops	22	0.03	0.32 %
Grassland	926	1.45	13.49 %
Forest & Woodland	1,000	1.56	14.57 %
Herbaceous	6	0.01	0.09 %
Wetland	19	0.03	0.28 %
Open Water	18	0.03	0.26 %
Barren	31	0.05	0.45 %
Total:	6,864	10.73	100.00 %

Source: MoRAP 2005b

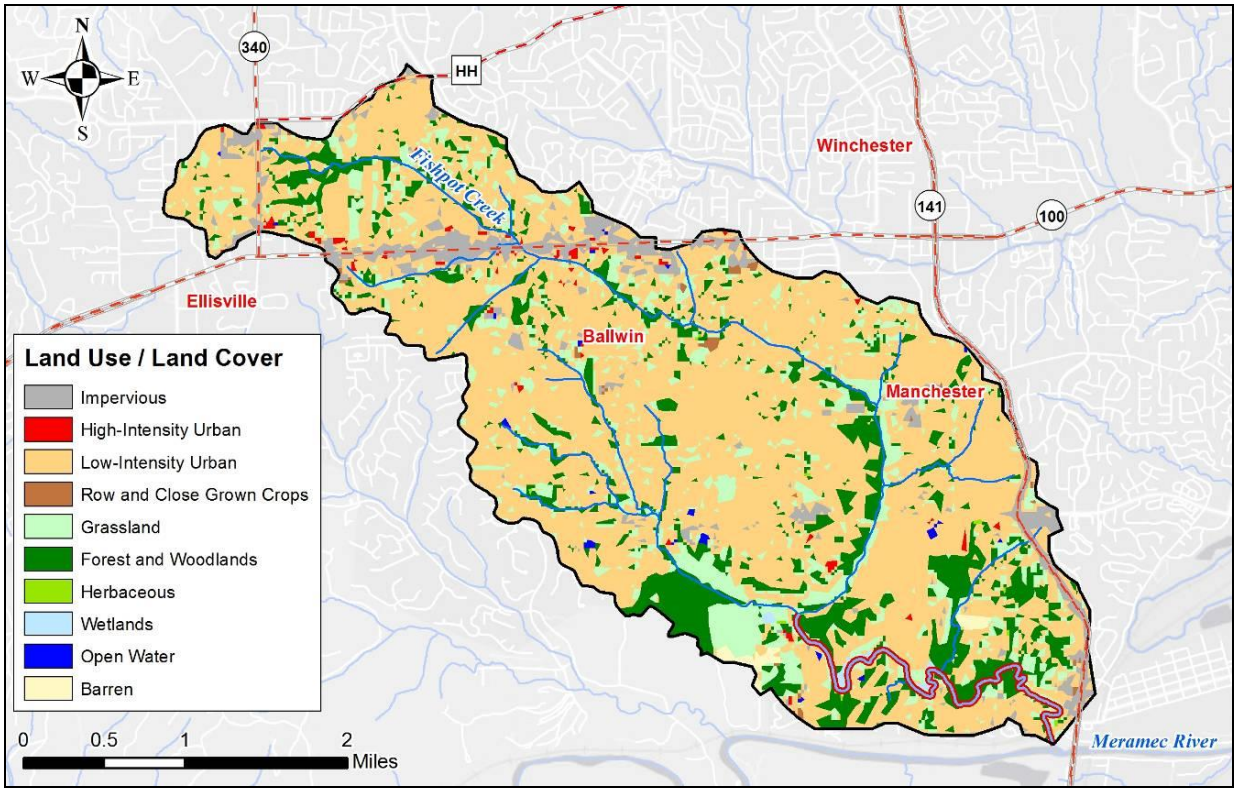

Figure 5. Land use in the Fishpot Creek watershed (MoRAP 2005b)

2.5 Defining the Problem

A TMDL is needed for Fishpot Creek, because the department has determined that this stream is not meeting the state bacteria water quality criterion for whole body contact recreation category B (See Section 4). Data collected from Fishpot Creek by the U.S. Geological Survey, or USGS, and the Metropolitan St. Louis Sewer District show exceedances of the state's whole body contact recreation category B criterion of 206 *E. coli* counts per 100 milliliters of water (206/100mL). This assessment is based on the geometric mean of samples collected during the state's recreational

season (April 1 through October 31). Bacteria data collected from Fishpot Creek within the last five years are expected to be representative of the stream's current condition. The recreational season bacteria data collected from 2006 – 2010 from Fishpot Creek are summarized in Table 4 and Figure 6. A summary of all *E. coli* data by month for this same period can be found in Figure 7. All available *E. coli* data collected from Fishpot Creek can be found in Appendix A.

High counts of *E. coli* may be an indication of fecal contamination and an increased risk of pathogen-induced illness to humans. *E. coli* are bacteria found in the intestines of humans and warm-blooded animals and are used as indicators of the risk of waterborne disease from pathogenic bacteria or viruses (EPA 1997). Infections due to pathogen-contaminated waters include gastrointestinal, respiratory, eye, ear, nose, throat, and skin diseases. To address these potential health risks, this TMDL targets instream bacteria levels using *E. coli* as the primary measurement parameter. Selection of *E. coli* as the numeric target enables the use of the highest quality data available and provides consistency with Missouri's water quality standards.

Table 4. Recreational season *E. coli* data for Fishpot Creek (2006 – 2010)*

Year	*Sampling Events*	*Geometric Mean*	*Minimum*	*Maximum*	*WBC Category†*	*WBC Criterion*	*Exceedance*
2006	4	76	50	270	B	206	--
2007	7	157	9	4,600	B	206	No
2008	6	92	27	230	B	206	No
2009	7	1,189	285	14,100	B	206	Yes
2010	4	393	52	1,090	B	206	--

* The units for all *E. coli* values are counts/100 mL of water. Years with fewer than five samples within the recreational season are not assessed for compliance with the whole body contact recreation criterion.
† WBC = whole body contact recreation

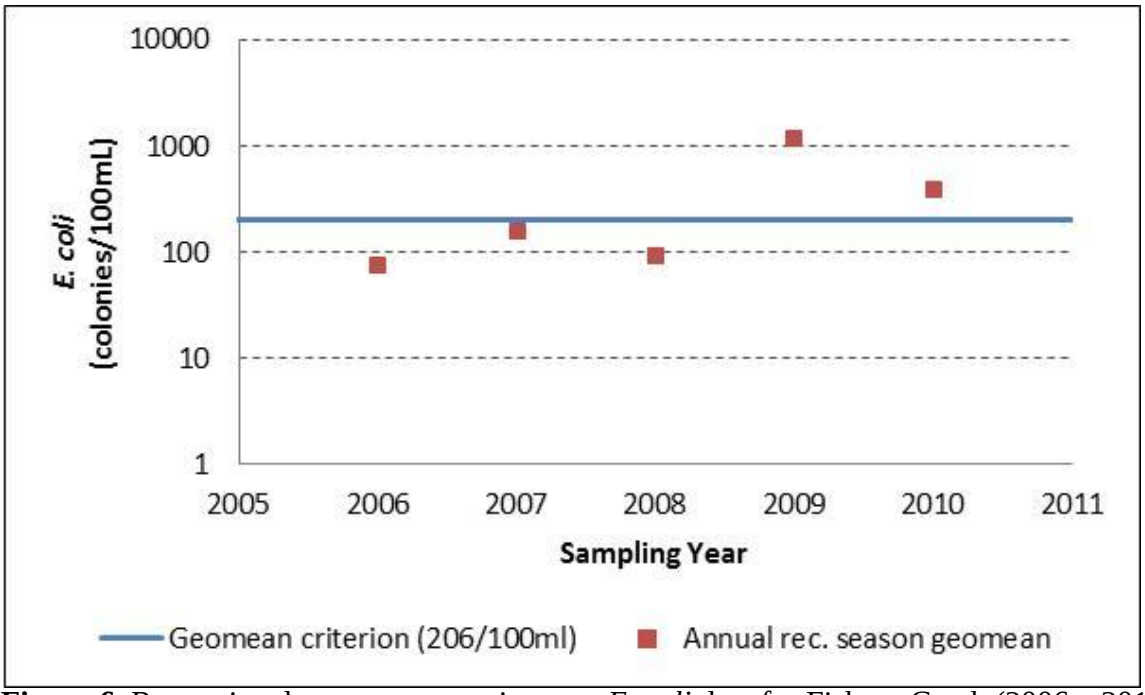

Figure 6. Recreational season geometric mean *E. coli* data for Fishpot Creek (2006 – 2010)

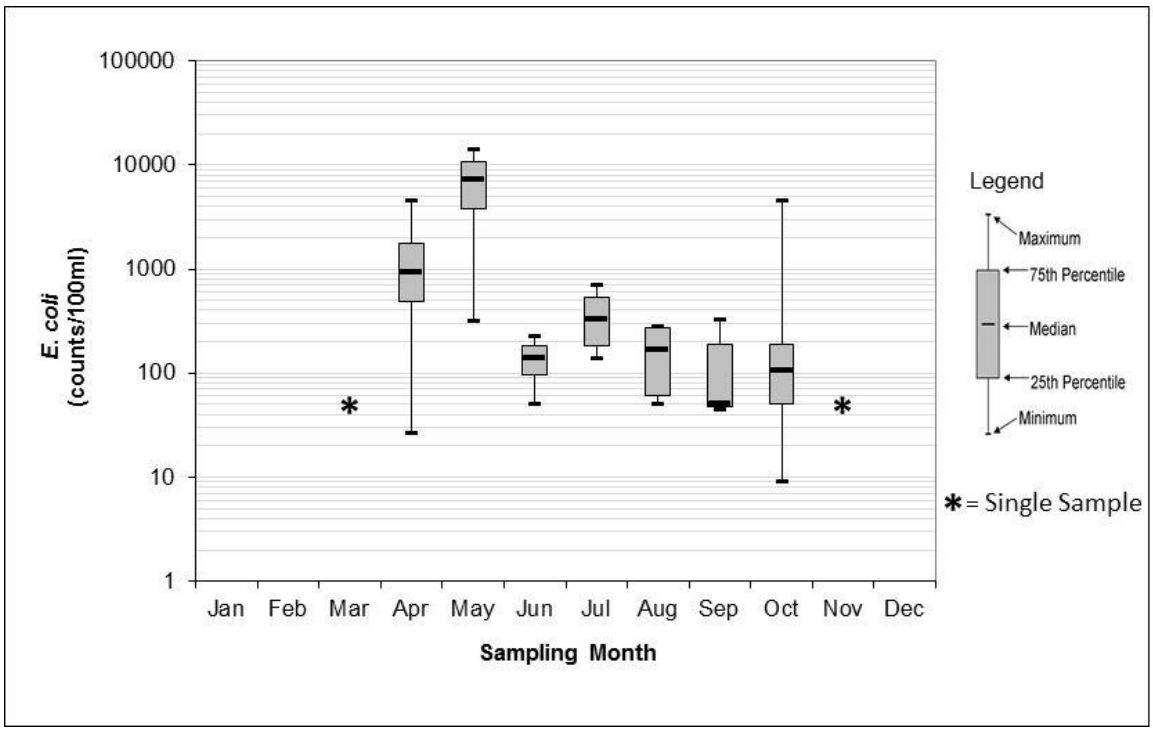

Figure 7. Monthly *E. coli* data for Fishpot Creek (2006 – 2010)

3. Source Inventory and Assessment

Source inventory and assessment characterizes known, suspected and potential sources of pollutant loading to the impaired water body. Pollutant sources identified within the watershed are categorized and quantified to the extent that information is available. Sources of pollutants may be point (regulated) or nonpoint (unregulated) in nature.

3.1 Point Sources

Point sources are defined under Section 502(14) of the federal Clean Water Act and are typically regulated through the Missouri State Operating Permit program[13] and include any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a water body. Under this definition, point sources include domestic and municipal wastewater treatment facilities, concentrated animal feeding operations, or CAFOs, stormwater discharges from municipal seperate storm sewer systems, illicit straight pipe discharges, and stormwater runoff from construction and industrial sites. Designated as a Metropolitan No-Discharge Stream, no water contaminant except uncontaminated cooling water, permitted stormwater discharges in compliance with permit conditions and excess wet-weather bypass discharges not interfering with designated uses may be discharged into Fishpot Creek.

At the time this document was written, the Fishpot Creek watershed contained 14 permitted entities. One of these permitted facilities has a site-specifc non-domestic wastewater permit and is authorized to discharge stormwater. The remaining 13 permited facilities have general stormwater permits, including two small municipal separate storm sewer system, or MS4, permits. There are no permitted CAFO facilities or domestic wastewater dischargers in this watershed. Figure 8 shows the location of the permitted outfalls within the watershed. The small MS4 permits regulate discharges of urban stormwater runoff throughout the entire watershed area.

[13] The Missouri State Operating Permit system is Missouri's program for administering the federal National Pollutant Discharge Elimination System (NPDES) program. The NPDES program requires all point sources that discharge pollutants to waters of the United States to obtain a permit.

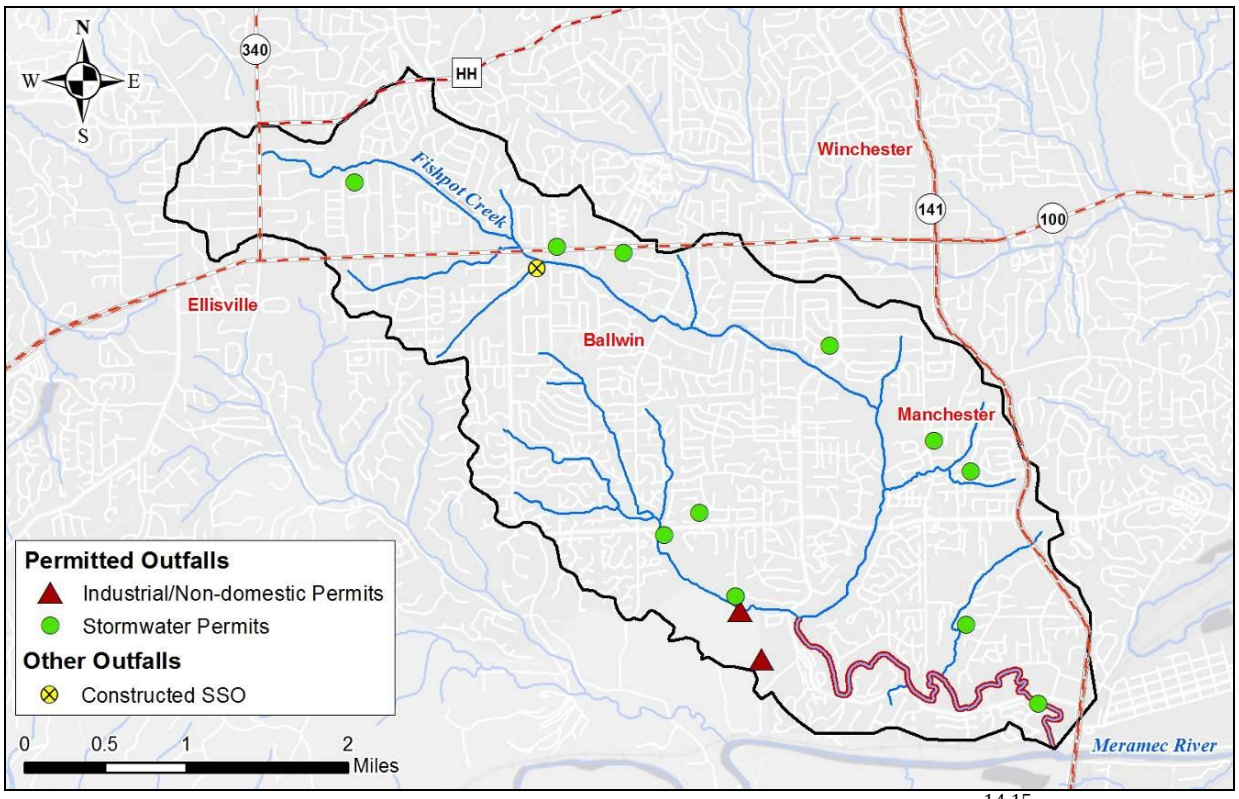

Figure 8. Outfall locations in the Fishpot Creek watershed (Oct. 18, 2012)[14,15]

3.1.1 Municipal and Domestic Wastewater Permits

There are no municipal or domestic wastewater permitted facilities or outfalls in the Fishpot Creek watershed. However, the urban area within the watershed is serviced by a sanitary sewer system maintained by the Metropolitan St. Louis Sewer District. A sanitary sewer system is designed to carry household waste, which includes both greywater and sewage, to a wastewater treatment facility, in this case the Grand Glaize wastewater treatment facility (permit no. MO-0101362) located about one mile east of the Fishpot Creek watershed. Although the treatment facility is located outside the watershed, the presence of the sewerage system infrastructure within the Fishpot Creek watershed is a potential source of bacteria due to possible overflows. Sanitary sewer overflows are untreated or partially treated sewage releases from a sanitary sewer system. Overflows can occur for a variety of reasons including blockages, line breaks, sewer defects, lapses in sewer system operation and maintenance, inadequate sewer design and construction, power failures and vandalism. Sanitary sewer overflows can occur during either dry or wet weather and at any point in the collection system, including manholes. Such overflows are unpermitted and are unauthorized by the federal Clean Water Act. Occurrences of sanitary sewer overflows can result in elevated bacteria concentrations (EPA 1996). For this reason, sanitary sewer overflows are potential sources of bacteria to Fishpot Creek. In addition to unintended overflows, constructed sanitary sewer overflows, installed to relieve the sanitary sewers from excess flow caused by inflow and infiltration of stormwater during high rain events, are found in some areas serviced by the Metropolitan St. Louis Sewer District. As shown in Figure 8, there is one constructed sanitary sewer overflow in the watershed located in Ballwin between Barton Lane and Parker Drive (Bruce

[14] SSO = sanitary sewer overflow.
[15] MS4 permits regulate stormwater runoff throughout the entire watershed area (permit no. MO-R040005 and MO-R040063).

Litzsinger, Metropolitan St. Louis Sewer District, email communication, Nov. 28, 2011). A USGS study of the sources of *E. coli* in metropolitan St. Louis streams with similar climatic conditions, land use, and bacteria sources as those found in the Fishpot Creek watershed, estimated that about one-third of the measured, instream *E. coli* in that study originated from humans. The study also indicated that there is a correlation between *E. coli* densities and upstream constructed sanitary sewer overflows (USGS 2010). For these reasons, the constructed sanitary sewer overflow is considered a potential source of bacteria to Fishpot Creek.

In addition to sanitary sewer overflows, combined sewer overflows are also present within some areas serviced by the Metropolitan St. Louis Sewer District. A combined sewer system collects both stormwater runoff and wastewater, including domestic sewage. These systems are designed to not only transport wastewater to treatment facilities, but to also discharge directly to a water body if its capacity is exceeded due to stormwater inputs. Combined sewer systems were an early sewer design and can be found in many older cities. As with sanitary sewer overflows, combined sewer overflows can result in periods of elevated bacteria concentrations in a water body due in large part to the discharge of domestic sewage as well as the runoff component from roofs, parking lots and residential yards and driveways. However, no combined sewer overflows exist within the Fishpot Creek watershed. Therefore, combined sewer overflows do not cause or contribute to the bacteria impairment of Fishpot Creek.

3.1.2 Industrial and Non-Domestic Wastewater Permits

Industrial and non-domestic facilities discharge wastewater resulting from non-sewage generating activities. For these reasons, industrial and non-domestic facilities are not expected to cause or contribute to the bacteria impairment of Fishpot Creek. There is one industrial and non-domestic wastewater facility with a site-specific permit in the Fishpot Creek watershed. This facility is the Veolia Environmental Services Oak Ridge Landfill, permit no. MO-0113000, which was known previously as the Onyx Oak Ridge Landfill. This facility has two outfalls that discharge stormwater runoff into Fishpot Creek. This facility does not have a specific design flow since discharge flow is dependent upon precipitation. The permit does not allow the discharge of stormwater that has contacted the open face of the landfill and does not allow the discharge of untreated leachate. This facility has recently ceased accepting waste and is currently undergoing closure activities including installation of a cap and the addition of clean fill.

3.1.3 General and Stormwater Permits

General and stormwater permits are issued based on the type of activity occurring and are meant to be flexible enough to allow for ease and speed of issuance, while providing the required protection of water quality. General and stormwater permits are issued to activities similar enough to be covered by a single set of requirements, and are designated with permit numbers beginning with “MO-G” or “MO-R” respectively. There are 13 facilities with stormwater permits within the Fishpot Creek watershed. These stormwater permits are summarized in Table 5. There are no facilities with general (MO-G) permits in the Fishpot Creek watershed.

Table 5. Stormwater (MO-R) permits in the Fishpot Creek watershed (Oct. 18, 2012)

Permit No.	***Facility Name***	***Discharge Type***	***Receiving Stream***	***Permit Expires***
MO-RA01867	The Arbors at Hanna	Stormwater	Trib. to Fishpot Cr.	2/7/2017
MO-RA01839	Arbor Valley Plat 3, Lots 84 – 89	Stormwater	Trib. to Fishpot Cr.	2/7/2017
MO-RA01749	Lemar Park	Stormwater	Trib. to Fishpot Cr.	2/7/2017
MO-RA01464	Valley Park Flood Protection Program	Stormwater	Trib. to Fishpot Cr.	2/7/2017
MO-RA01359	Hanna Road Bridge Replacement	Stormwater	Trib. to Fishpot Cr.	2/7/2017
MO-RA00662	Arbor Valley, Plat 1 – 3	Stormwater	Trib. to Fishpot Cr.	2/7/2017
MO-RA00337	C.A.P. Carpet	Stormwater	Trib. to Fishpot Cr.	2/7/2017
MO-RA00158	Elco Cadillac	Stormwater	Trib. to Fishpot Cr.	2/7/2017
MO-R040005	Metropolitan St. Louis Sewer District and co-permittees' Small MS4	Stormwater	--	6/12/2013
MO-R040063	Missouri Dept. of Transportation Small MS4	Stormwater	--	6/12/2013
MO-R23A081	Senoret Chemical Co Inc.	Stormwater	Trib. to Fishpot Cr.*	3/11/2015
MO-R10D963	Tuscan Valley	Stormwater	Trib. to Fishpot Cr.	2/7/2012
MO-R109W23	Oak Valley	Stormwater	Trib. to Fishpot Cr.	3/7/2012

*****Permit mistakenly identifies receiving stream as a tributary to Gravois Creek.

As noted in Table 5, there are two small MS4 permits regulating pollutant contributions from urban stormwater runoff throughout the Fishpot Creek watershed. Urban runoff has been found to carry high levels of bacteria and can be expected to exceed water quality criteria for bacteria during and immediately after storm events in most streams throughout the country (EPA 1983). *E. coli* contaminated runoff can come from both heavily paved areas and from open areas where soil erosion is common (Burton and Pitt 2002). For these reasons, urban runoff is a significant potential contributor of bacteria to Fishpot Creek.

Bacterial inputs to streams from urban runoff can be caused by sanitary sewer overflows as discussed in Section 3.1.1 of this document, but also commonly results from residential and green space runoff carrying domestic and wild animal wastes. Birds, dogs, cats, and rodents have been documented as common sources of *E. coli* contamination in urban stormwater (Burton and Pitt 2002). The USGS study specific to the sources of *E. coli* in metropolitan St. Louis streams discussed in Section 3.1.1 of this document estimated that in addition to the one third of bacteria originating from human sources, approximately 10 percent of the *E. coli* originated from dogs and 20 percent from geese (USGS 2010). Another component of urban runoff is runoff originating from highway corridors. The Federal Highway Administration published research showing that runoff from highway corridors may also contain bacteria. Sources of *E. coli* to highway areas identified in the study include bird droppings, soil, and vehicles carrying livestock and stockyard wastes (FHWA 1984). However, due to differences in the origins of bacteria from highway systems as opposed to other urban areas, it is likely that bacteria contributions from highway corridors are smaller than those contributions from portions of the watershed where residential areas dominate and contributions from pet waste, sanitary sewer overflows, or onsite wastewater treatment systems are more likely.

Stormwater discharges of urban runoff within the entire Fishpot Creek watershed are regulated through MS4 permits. For this reason, urban stormwater runoff is considered a point source for this TMDL. Although stormwater discharges are untreated, small MS4 permit holders must develop, implement, and enforce stormwater management plans to reduce the contamination of stormwater runoff and prohibit illicit discharges. These plans must include measurable goals, must be reported on annually, and must meet six minimum control measures. These six minimum control measures are public education and outreach, public participation and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention. Entities within the Fishpot Creek watershed that are regulated under the MS4 permits noted in Table 5 include the Missouri Department of Transportation and the Metropolitan St. Louis Sewer District and its co-permittees, which include St. Louis County and the municipalities of Ballwin, Ellisville, Manchester, Valley Park and Winchester.

Regarding the remaining stormwater permits in Table 5, the department assumes activities in the watershed will be conducted in compliance with all permit conditions, including monitoring and discharge limitations. It is expected that compliance with these permits will result in bacterial loadings at or below applicable targets. For these reasons, these facilities are not expected to cause or contribute to the bacterial impairment of Fishpot Creek. If at any time the department determines that the water quality of streams in the watershed is not being adequately protected, the department, may require the owner or operator of the permitted site to obtain a site-specific operating permit per 10 CSR 20-6.010(13)(C).

3.1.4 Illicit Straight Pipe Discharges

Illicit straight pipe discharges of household waste are also potential point sources of bacteria. These sources are illegal and unpermitted discharges straight into streams or land areas and are different from illicitly connected sewers. However, there are no specific data on the number or presence of illicit straight pipe discharges of household waste in the Fishpot Creek watershed. Due to the presence of a sewerage system throughout the watershed, illicit straight pipe discharges are not expected to be significant contributors of *E. coli* to Fishpot Creek. Illicit discharge detection and elimination is one of the six minimum control measures required by an MS4 permit. Such sources are therefore expected to be detected and eliminated in accordance with permitted conditions.

3.2 Nonpoint Sources

Nonpoint source pollution refers to pollution coming from diffuse, non-permitted sources that typically cannot be identified as entering a water body at a single location. They include all other categories of pollution not classified as being from a point source, and are exempt from department permit regulations as per state rules at 10 CSR 20-6.010(1)(B)1. These sources involve stormwater runoff from non-regulated areas and are minor or negligible under low-flow conditions. Typical nonpoint sources of pollution that have the potential to influence water quality include various sources associated with runoff from agricultural and non-MS4 permitted urban areas, onsite wastewater treatment systems, and riparian corridor conditions.

3.2.1 Agricultural Runoff

Stormwater runoff from lands used for agricultural purposes is often a source of bacterial loading to water bodies. Activities associated with agricultural land uses that may contribute bacteria to a water body include manure fertilization of croplands or pastures, and livestock grazing. As noted in Table 3, areas categorized as cropland account for less than 1 percent of the entire watershed area.

However, this small area is probably the result of normal error inherent in the processing of aerial imagery, and the true extent of cropland is likely to be much less and probably nonexistent. In fact, a comparison of the available land use data with 2010 National Agriculture Imagery Program aerial imagery shows areas in the Fishpot Creek watershed categorized as cropland to actually include rooftops and parking lots (USDA 2010). For these reasons, bacterial inputs from cropland are not likely to be significant or potential contributors to the impaired condition of Fishpot Creek. Likewise, bacterial inputs to Fishpot Creek from livestock are likely to be equally insignificant. Although over 13 percent of the watershed is classified as grassland, due to the urban nature of the watershed these areas include golf courses, cemeteries, parks, schoolyards and other urban green spaces where livestock animals are not likely to be grazing. However, although agricultural livestock production is not likely to contribute bacteria to Fishpot Creek, open green spaces within urban watersheds may still contribute bacteria via stormwater runoff contaminated by wildlife or domestic pet waste (Section 3.1.3). Runoff from these areas in the Fishpot Creek watershed is regulated through MS4 permits and is considered a point source for purposes of this TMDL.

3.2.2 Urban Runoff (non-MS4 permitted areas)

Stormwater runoff from urban areas not having MS4 permits is considered a nonpoint source. In the Fishpot Creek watershed, stormwater runoff falls within the jurisdiction of two MS4 permits. Therefore, for purposes of this TMDL, urban runoff within the Fishpot Creek watershed is considered a potential point source contributor of *E. coli* to Fishpot Creek. For this reason, no nonpoint urban runoff sources have been identified that are likely to be contributing to the bacteria impairment of Fishpot Creek. See Section 3.1.3 of this document for a more detailed discussion of urban runoff contributions and MS4 permitting.

3.2.3 Onsite Wastewater Treatment Systems

When properly designed and maintained, onsite wastewater treatment systems (e.g., home septic systems) should not serve as a source of contamination to surface waters; however, onsite wastewater treatment systems do fail for a variety of reasons. When these systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration), there can be adverse effects to surface water quality (Horsley and Witten 1996). Failing onsite wastewater treatment systems are known to be sources of bacteria, which can reach nearby streams through surface runoff and groundwater flows, thereby contributing bacteria loads under either wet or dry weather conditions. Onsite wastewater treatment systems may contribute bacteria to Fishpot Creek either directly or as a component of MS4-permitted stormwater.

The exact number of onsite wastewater treatment systems in the Fishpot Creek watershed is unknown. However, such systems are known to exist in older areas of the county that were developed prior to the sewerage systems serviced by the Metropolitan St. Louis Sewer District (Jack Fischer, St. Louis County Public Works, personal communication, June 6, 2011). Onsite systems may also exist in areas zoned by the county as non-urban, since these areas are defined as being areas that create "practical difficulties in providing and maintaining…public or private utility services..." (St. Louis County 2011). Although septic system installations and repairs within St. Louis County require a permit, the county database cannot distinguish between work pertaining to onsite wastewater treatment systems and work pertaining to sanitary sewers because they are classified the same (Jack Fischer, St. Louis County Public Works, personal communication, Jan. 31, 2011). The Metropolitan St. Louis Sewer District maintains parcel and billing information that can be used to estimate the number of parcels in the watershed without a sewer connection. The

majority of parcels in the watershed, approximately 99 percent, do have a sewer connection. Nonsewered or suspected nonsewered parcels in the watershed may include parcels with houses or other structures on them as well as parcels comprised entirely of green space. These parcels may have an onsite wastewater system on them. The Metropolitan St. Louis Sewer District confirms that just over 0.6 percent of the parcels in the Fishpot Creek watershed, approximately 90 parcels, are not connected to a sewer. However, is not known if an onsite system exists on these parcels. An additional 0.2 percent of the parcels in the watershed, approximately 26 parcels, are suspected of not having a sewer connection. (Kristol Whatley, Metropolitan St. Louis Sewer District, email communication, Aug. 10, 2012).

Much of the Fishpot Creek watershed is serviced by the Metropolitan St. Louis Sewer District's Grand Glaize wastewater treatment facility located about 1 mile east of the watershed. Due to the availability of this sewer system and a St. Louis County ordinance requiring that a sewer connection to a building be made when a sanitary sewer line is within 200 feet of the property, many septic system eliminations have likely been made. The consent decree established as part of the *United States of America and the State of Missouri, and Missouri Coalition for the Environment Foundation v. Metropolitan St. Louis Sewer District*, No. 4:07-CV-1120 also requires the implementation of a supplemental environmental project to decommission some septic tanks and repair or replace laterals to low-income residents within the Metropolitan St. Louis Sewer District's service area. This project could aid in further reducing the number of septic tanks within the watershed, however overall reductions are dependent upon availability of funding for this supplemental project.[16]

EPA's Spreadsheet Tool for Estimating Pollutant Load website estimates the failure rate of onsite wastewater treatment systems in St. Louis County as being 39 percent (EPA 2011b). A more recent study conducted by the Electric Power Research Institute suggests that up to 50 percent of onsite wastewater treatment systems in Missouri may be failing (EPA 2011c; EPRI 2000). Despite the lack of specific data showing that onsite wastewater treatment systems are a significant problem in the Fishpot Creek watershed, the available failure rate data suggests that onsite wastewater treatment systems in the watershed are potential contributors of bacteria to Fishpot Creek either directly or as a component of MS4 stormwater. However, due to the overall urban nature of the watershed, the number of onsite wastewater systems in the watershed is expected to be low.

3.2.4 Riparian Corridor Conditions

Riparian (streamside) corridor conditions can have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the detention, removal and assimilation of pollutants from runoff. Therefore, a stream with good riparian cover is better able to moderate the impacts of high pollutant loads than a stream with poor or no riparian cover.

Table 6 presents land use data for the riparian corridor within the Fishpot Creek watershed. This analysis used the land use data calculated in Section 2.4 and defined the riparian corridor as

[16] Any references to implementation of a supplemental environmental project shall include the following reference: "This project was undertaken in connection with the settlement of an enforcement action, *United States of America and the State of Missouri, and Missouri Coalition for the Environment Foundation v. Metropolitan St. Louis Sewer District*, No. 4:07-CV-1120-CEJ, taken on behalf of the U.S. Environmental Protection Agency, State, and the Coalition under the Clean Water Act" (John R. Lodderhose, Metropolitan St. Louis Sewer District, email communication, Oct. 24, 2012).

including a 30-meter area on each side of all streams included in the National Hydrography Dataset 1 to 24,000-scale flowline.[17] As can be seen in Table 6, the riparian corridor of Fishpot Creek is predominantly urban. Land classified as low-intensity urban comprises over 41 percent of the riparian corridor. Runoff from low-intensity urban areas, such as residential areas, can contribute bacteria loading to a water body from pet or wild animal wastes. For this reason, the riparian corridor conditions in the watershed are likely to contribute to the bacteria impairment of Fishpot Creek. Vegetated areas categorized as forest and woodland count for about 34 percent of the Fishpot Creek riparian corridor, while area classified as grassland accounts for about 20 percent. In rural areas, grassland areas may provide higher bacterial loading than forest and woodland areas due to the presence of livestock. Due to the highly urbanized environment of the Fishpot Creek watershed, livestock inputs are not likely to be contributing significantly to the bacteria impairment. However, bacterial inputs from these urban green spaces may still occur from pets and wildlife. Areas within the riparian corridor of Fishpot Creek are within the urban area described by EPA as requiring MS4 permit regulations (see Section 2.3). Therefore, for purposes of this TMDL, stormwater runoff from these areas is considered a regulated point source (see Section 3.1.2).

Table 6. Land use data for the Fishpot Creek watershed riparian buffer, 30-meter

Land Use Category	*Acres*	*Square Miles*	*Percent*
Impervious	14.90	0.02	2.93 %
High-Intensity Urban	1.11	0.00	0.22 %
Low-Intensity urban	210.82	0.33	41.45 %
Row and close-grown crops	0.44	0.00	0.09 %
Grassland	99.18	0.15	19.50 %
Forest and woodland	171.46	0.27	33.71 %
Open water	1.33	0.00	0.26 %
Barren	0.22	0.00	0.04 %
Herbaceous	0.89	0.00	0.17 %
Wetlands	8.23	0.01	1.62 %
Total:	508.58	0.78	99.99 %

Source: MoRAP 2005b

4. Applicable Water Quality Standards and Numeric Target

The purpose of developing a TMDL is to identify the pollutant loading that a water body can assimilate and still achieve water quality standards. Water quality standards are therefore central to the TMDL development process. Under the federal Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters (U.S. Code Title 33, Chapter 26, Subchapter III). Water quality standards consist of three components: designated uses, water quality criteria, and an antidegradation policy.

[17] The National Hydrography Dataset is digital surface water data for geographic information systems (GIS) for use in general mapping and in the analysis of surface-water systems. Available URL: http://nhd.usgs.gov

4.1 Designated Uses

Designated uses are the uses for a water body identified in the state water quality standards that must be maintained in accordance with the federal Clean Water Act. The following designated uses have been assigned to Fishpot Creek:

- Livestock and wildlife protection (LWP)
- Protection of warm water habitat (WWH)
- Human health protection (HHP)
- Whole body contact recreation category B (WBC-B)

The use impaired by bacteria in this stream is the protection of whole body contact recreation category B. Whole body contact recreation includes activities in which there is direct human contact with surface water that results in complete body submergence, thereby allowing accidental ingestion of the water as well as direct contact to sensitive body organs, such as the eyes, ears and nose. Category A waters include water bodies that have been established as public swimming areas and waters with documented existing whole body contact recreational uses by the public. Category B applies to waters designated for whole body contact recreation, but are not contained within category A.

4.2 Water Quality Criteria

Water quality criteria are limits on particular chemicals or conditions in a water body to protect particular designated uses. Water quality criteria can be expressed as specific numeric criteria or as general narrative statements.

In Missouri's water quality standards at 10 CSR 20-7.031(5)(C), specific numeric criteria are given for the protection of the whole body contact recreation use. For category B waters, *E. coli* counts, measured as a geometric mean, shall not exceed 206 counts/100 mL of water during the recreational season. The state's recreational season is defined as being from April 1 to October 31.

4.3 Antidegradation Policy

Missouri's Water Quality Standards include the EPA "three-tiered" approach to antidegradation, and may be found at 10 CSR 20-7.031(3).

Tier 1 – Protects existing uses and a level of water quality necessary to maintain and protect those uses. Tier 1 provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after Nov. 28, 1975, the date of EPA's first Water Quality Standards Regulation.

Tier 2 – Protects and maintains the existing level of water quality where it is better than applicable water quality criteria. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economic and social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national and state resource waters, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality.

Waters in which a pollutant is at, near or exceeds the water quality criteria are considered in Tier 1 status for that pollutant. Therefore, the antidegradation goals for Fishpot Creek are to restore the streams' water quality to levels that meet water quality standards.

4.4 Numeric Target for TMDL Development

As noted in Section 4.2 of this document, Missouri's water quality standards include a specific numeric *E. coli* water quality criterion of 206 *E. coli* counts per 100 mL of water, measured as a geometric mean during the recreational season for waters designated with the whole body contact recreation category B use. The concentration value of 206 counts/100 mL will serve as the numeric target for TMDL development. This targeted concentration will be expressed as a daily load that varies with flow using a load duration curve. Achieving this targeted load will also result in achieving the state's whole body contact recreation category B water quality criterion.

5. Modeling Approach

For Fishpot Creek the load duration approach was used. When stream flow gage information is available, a load duration curve is useful in identifying and differentiating between storm-driven and steady-input pollutant sources. The load duration approach may be used to provide a visual representation of stream flow conditions under which pollutant criteria exceedances have occurred, to assess critical conditions, and to estimate the level of pollutant load reduction necessary to meet the surface water quality targets in the stream (Cleland 2002; Cleland 2003).

A load duration curve also identifies the maximum allowable daily pollutant load for any given day as a function of the flow occurring that day, which is consistent with the Anacostia Ruling (*Friends of the Earth, Inc., et al v. EPA*, No 05-5010, April 25, 2006) and EPA guidance in response to this ruling (EPA 2006; EPA 2007a). EPA guidance recommends that all TMDLs and associated pollutant allocations be expressed in terms of daily time increments, and suggests that there is flexibility in how these daily increments may be expressed. This guidance indicates that where pollutant loads or water body flows are highly dynamic, it may be appropriate to use a load duration curve approach, provided that such an approach "identifies the allowable daily pollutant load for any given day as a function of the flow occurring on that day." In addition, for targets that are expressed as a concentration of a pollutant, it may be appropriate to use a table or graph to express individual daily loads over a range of flows as a product of a water quality criterion multiplied by stream flow and a conversion factor (EPA 2006).

Average daily flow data for Fishpot Creek were directly available from July 18, 1996 to May 2, 2011, from the USGS gaging station USGS 07019120 Fishpot Creek at Valley Park, Mo. (Figure 9). Flow data from this gage was adjusted to the drainage areas of the impaired watershed based on the ratio of the impaired watershed area to the gage drainage area of 9.58 square miles. A detailed discussion of the methods used to develop the bacteria load duration curve is presented in Appendix B.

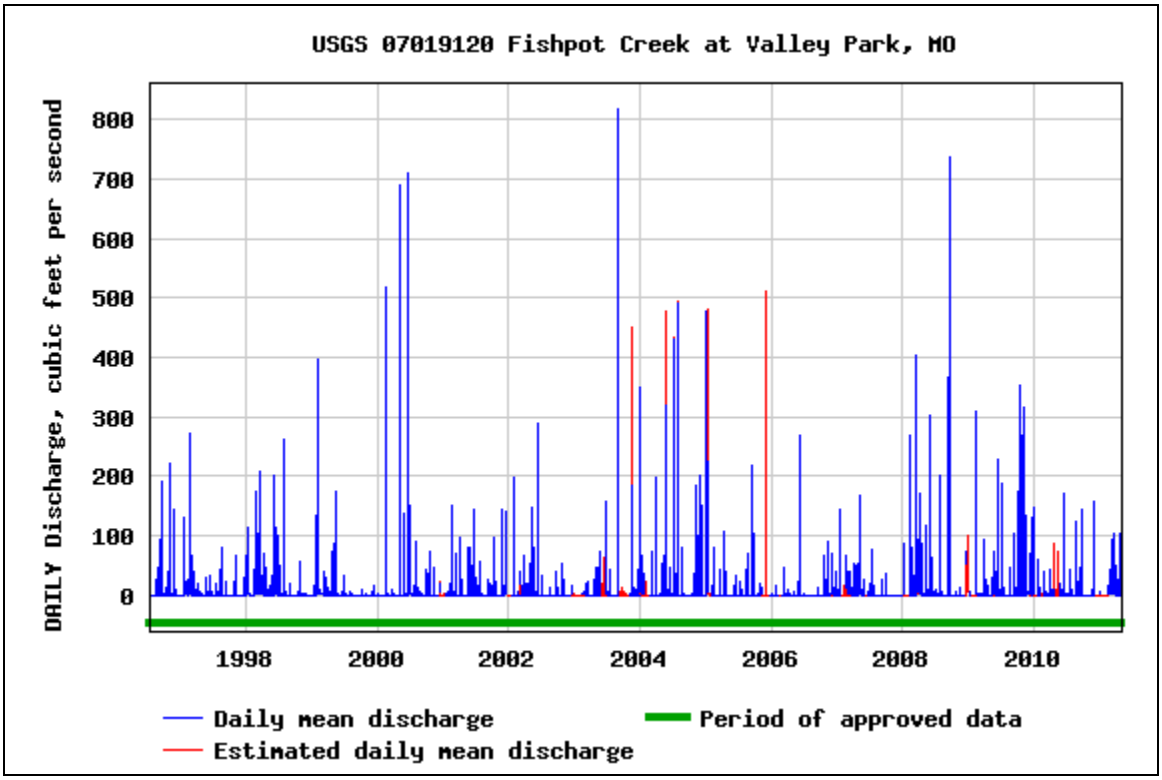

Figure 9. 1996 – 2011 flow data from USGS stream gage 07019120 (USGS 2011)

6. Calculating Loading Capacity

A TMDL calculates the loading capacity of a water body and allocates that load among the various pollutant sources in the watershed. The loading capacity is the maximum pollutant load that a water body can assimilate and still attain water quality standards. It is equal to the sum of the wasteload allocation, load allocation and the margin of safety, and can be expressed as the equation:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

where LC is the loading capacity, ∑WLA is the sum of the wasteload allocations, ∑LA is the sum of the load allocations, and MOS is the margin of safety.

According to 40 CFR §130.2(i), TMDLs can be expressed in terms of mass per time, toxicity or other appropriate measures. For Fishpot Creek, bacteria TMDLs are expressed as *E. coli* counts per day using a load duration curve. To develop a load duration curve, the TMDL target is multiplied by the flow and a conversion factor to generate the allowable load at different flows. Figure 10 is the bacteria TMDL load duration curve calculated for Fishpot Creek. The y-axis describes bacteria loading as counts per day, which are plotted against the flow duration intervals on the x-axis, which represent the frequency for which a particular flow is met or exceeded. The load duration curve presented in Figure 10 represents the loading capacity as a solid curve over the range of flows. Bacteria measurements collected during the recreational season from the impaired segment are plotted as blue points. Geometric means of the bacteria data that are exceeding the TMDL are plotted as green triangles within a specific flow condition (i.e., high flows). Flow condition ranges presented in Figure 10 illustrate general base-flow and surface-runoff conditions consistent with EPA guidance on using load duration curves for TMDL development (EPA 2007b). Table 7

presents the TMDL loading capacity and the TMDL allocations for Fishpot Creek over a range of flows.

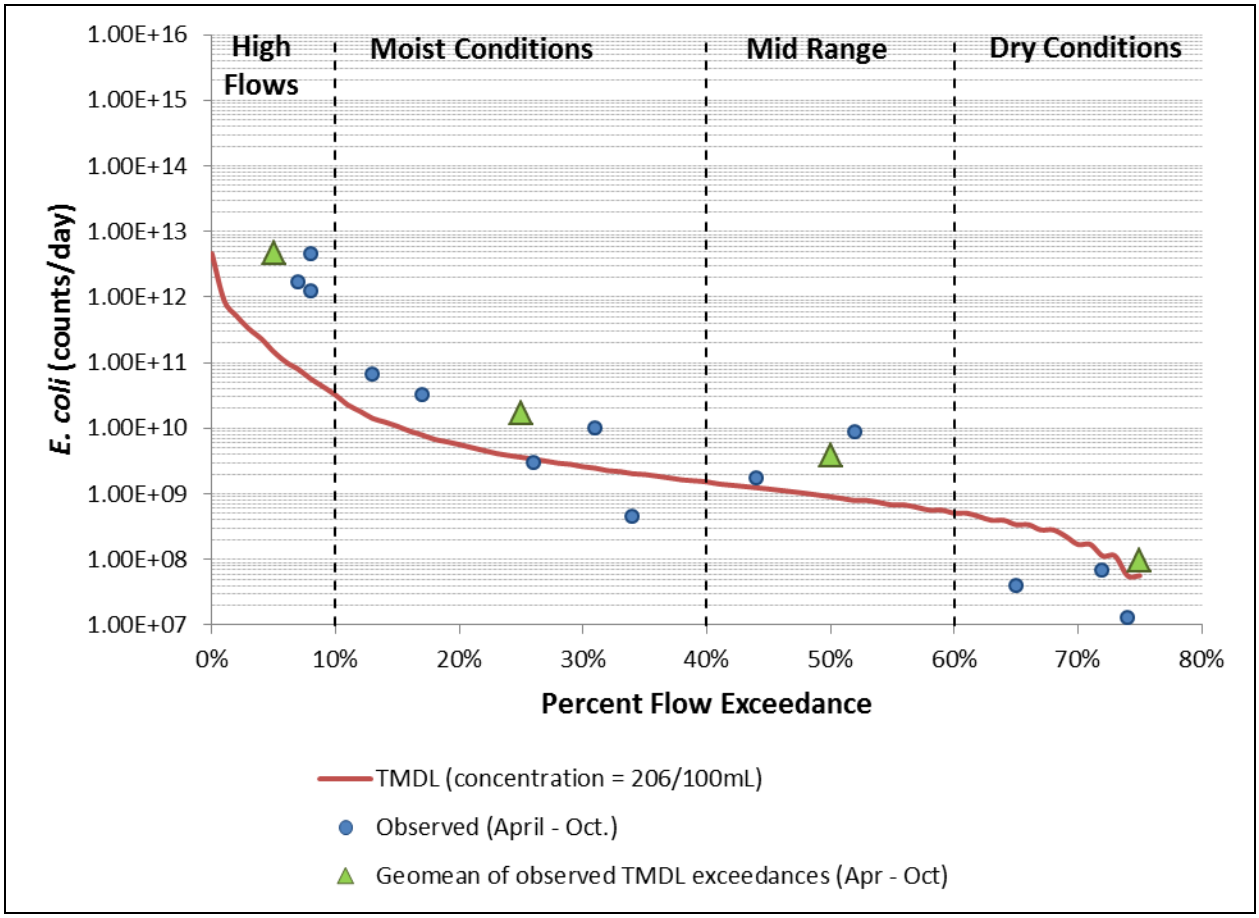

Figure 10. Fishpot Creek, WBID 2186, load duration curve

Table 7. *E. coli* TMDL for Fishpot Creek over a range of flows*

Percentile Flow Exceedance	*Flow (cfs)*	*Targets Based on concentration of 206/100mL*			
		TMDL (counts/day)	*MS4 WLA (counts/day)*	*LA (counts/day)*	*MOS (counts/day)*
90	0	0	0	0	0
75	0.01	5.65E+07	5.08E+07	0	5.65E+06
50	0.18	9.03E+08	8.13E+08	0	9.03E+07
25	0.72	3.61E+09	3.25E+09	0	3.61E+08
10	6.37	3.21E+10	2.89E+10	0	3.21E+09

* cfs = cubic feet per second; WLA = wasteload allocation; LA = load allocation; MOS = margin of safety

7. Wasteload Allocation (Point Source Load)

The wasteload allocation is the allowable amount of the pollutant load that can be allocated to existing or future point sources. Typically, point sources are permitted with limits for a given pollutant that are the most stringent of either technology-based effluent limits or water quality-based effluent limits. Technology-based effluent limits are based upon the expected capability of a

treatment method to reduce the pollutant to a certain concentration. Water quality-based effluent limits represent the most stringent concentration of a pollutant that a receiving stream can assimilate without violating applicable water quality standards at a specific location. The total wasteload allocations in the Fishpot Creek watershed over a range of flows are presented in Table 7.

As noted in Section 3.1.2 of this document, the only site-specific permitted facility in the watershed is the Veolia Environmental Services Oak Ridge Landfill. This facility is not expected to cause or contribute to the *E. coli* impairment of Fishpot Creek and is therefore given a wasteload allocation of zero. Although there are no permitted domestic dischargers in the watershed, a sewerage system is present. This system discharges from a treatment works facility located outside of the watershed. Even so, dry or wet weather sanitary sewer overflows may still occur and one constructed sanitary sewer overflow is present in the watershed. These overflows are unpermitted and not authorized under the Clean Water Act. For this reason, sanitary sewer overflows in the Fishpot Creek watershed are given a wasteload allocation of zero. Elimination of bacteria loading from these sources will be accomplished through the requirements of the Metropolitan St. Louis Sewer District's consent decree.

Stormwater runoff is another potential contributor of bacteria loading to Fishpot Creek. In the Fishpot Creek watershed, stormwater runoff is regulated through MS4 permitting. Bacterial contributions from MS4 permitted entities are precipitation dependent and vary with flow. Because the entire watershed area is regulated through MS4 permits and there are no other permitted facilities found to cause or contribute to the impairment, and because there is insufficient data to adequately disaggregate the MS4 wasteload allocation among the permitted entities, all wasteload allocations are aggregated and allocated to the total MS4 area. For this TMDL, the MS4 wasteload allocation is the remainder of the loading capacity after allocations to the margin of safety (Table 7).

Table 5 lists other facilities with general or non-MS4 stormwater permits; however, the department assumes activities in the watershed will be conducted in compliance with all permit conditions, including monitoring and discharge limitations. It is expected that compliance with these permits will result in bacterial loading at or below applicable targets. For these reasons, these facilities are not expected to cause or contribute to the bacteria impairment of Fishpot Creek. If at any time the department determines that the water quality of streams in the watershed is not being adequately protected, the department may require the owner or operator of the permitted site to obtain a site-specific operating permit per 10 CSR 20-6.010(13)(C). The wasteload allocation for these general and non-MS4 stormwater permitted dischargers is zero.

The wasteload allocations listed in this TMDL do not preclude the establishment of future point sources of bacterial loading in the watershed. Any future point sources should be evaluated against the TMDL and the range of flows, which any additional bacterial loading will affect.

8. Load Allocation (Nonpoint Source Load)

The load allocation is the allowable amount of the pollutant load that can be assigned to nonpoint sources and includes all existing and future nonpoint sources, as well as natural background contributions (40 CFR §130.2(g)). Nonpoint sources identified in the TMDL to be potential contributors of bacteria include onsite wastewater treatment systems. If functioning properly, these systems should not be contributing to the impaired condition of Fishpot Creek. Stormwater runoff within the watershed is regulated by MS4 permits. Therefore, for purposes of this TMDL, stormwater runoff is considered a point source and stormwater contributions are considered in the wasteload allocation. For these reasons, load allocations are set to zero at all flows.

9. Margin of Safety

A margin of safety is required in the TMDL calculation to account for uncertainties in scientific and technical understanding of water quality in natural systems. The margin of safety is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the margin of safety can be achieved through two approaches:

- Explicit - Reserve a portion of the loading capacity as a separate term in the TMDL.
- Implicit - Incorporate the margin of safety as part of the critical conditions for the wasteload allocation and the load allocation calculations by making conservative assumptions in the analysis.

The margin of safety for this TMDL is an explicit 10 percent as shown in Table 7. Furthermore, bacterial decay or die off was not accounted for in the establishment of this TMDL. This conservative assumption provides an additional implicit margin of safety. Together, the explicit and implicit margins of safety account for any modeling uncertainties and data inadequacies, such as potential loading contributions from bacteria resuspension.

10. Seasonal Variation

Missouri's water quality criteria for the protection of whole body contact recreation are applicable during the recreational season defined as being from April 1 to October 31. The TMDL load duration curve represents stream flow under all conditions. For this reason, the *E. coli* targets and allocations established in this TMDL will be protective throughout the recreational season. The advantage of a load duration curve approach is that all flow conditions are considered and the constraints associated with using a single-flow critical condition are avoided.

11. Monitoring Plans

The department has not yet scheduled post-TMDL monitoring for Fishpot Creek. Post-TMDL monitoring is usually scheduled and carried out by the department approximately three years after the approval of the TMDL or in a reasonable time following completion of permit compliance schedules and the application of new effluent limits, or following significant implementation actions such as the removal of constructed sanitary sewer overflows. The department will routinely examine water quality data collected by other local, state and federal entities in order to assess the effectiveness of TMDL implementation. Such entities may include the USGS, EPA, the Missouri

Department of Health and Senior Services, the Missouri Department of Conservation, county health departments, and the Metropolitan St. Louis Sewer District. In addition, certain quality-assured data collected by universities, municipalities, private companies and volunteer groups may potentially be considered for monitoring water quality following TMDL implementation.

12. Reasonable Assurance

Section 303(d)(1)(C) of the federal Clean Water Act requires that TMDLs be established at a level necessary to implement applicable water quality standards. As part of the TMDL process, consideration must be given to the assurances that point and nonpoint source allocations will be achieved and water quality standards attained. Where TMDLs are developed for waters impaired by point sources only, reasonable assurance is derived from the National Pollutant Discharge Elimination System permitting program through discharge permits issued with effluent limits as stringent as necessary to meet water quality standards (CWA Section 301(b)(1)(C)). For impaired waters, these discharge permits must be issued so that effluent limits are consistent with the assumptions and requirements of approved TMDL wasteload allocations (40 CFR 122.44(d)(1)(vii)(B)). The department has the authority to issue and enforce Missouri State Operating Permits for point source discharges. Inclusion of effluent limits in a state operating permit and requiring that effluent and instream monitoring be reported to the department should provide reasonable assurance that instream water quality standards will be met. The Clean Water Act at Section 402(p)(3)(B)(iii) provides that stormwater permits for MS4 permits contain controls to reduce pollutants to the "maximum extent practicable" and such other provisions as the EPA administrator or the state determine appropriate. Under this provision, the permitting authority has the discretion to include requirements for reducing pollutants in stormwater discharges as necessary for compliance with water quality standards (EPA 2010). This permitting discretion provides reasonable assurance that appropriate pollutant reductions from MS4 permitted entities will occur.

The consent decree established as part of the *United States of America and the State of Missouri, and Missouri Coalition for the Environment Foundation v. Metropolitan St. Louis Sewer District*, No. 4:07-CV-1120 requires specific eliminations and reductions of point sources in the Metropolitan St. Louis Sewer District's service area, for which Fishpot Creek is a part. This court-approved decree will provide additional reasonable assurance of bacteria reductions in Fishpot Creek from point sources over a 23-year period (EPA 2011d)

Where a TMDL is developed for waters impaired by both point and nonpoint sources, point source wasteload allocations must be stringent enough so that in conjunction with the water body's other loadings (i.e., nonpoint sources) water quality standards are met. This generally occurs when the TMDL's combined nonpoint source load allocations and point source wasteload allocations do not exceed the water quality standards-based loading capacity and there is reasonable assurance that the TMDL's allocations can be achieved. Reasonable assurance that nonpoint sources will meet their allocated amount in the TMDL is dependent upon the availability and implementation of nonpoint source pollutant reduction plans, controls or BMPs within the watershed. If BMPs or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs (40 CFR 130.2(i)). When a demonstration of nonpoint source reasonable assurance is developed and approved for an impaired water body, additional pollutant allocations for point sources may be allowed provided water quality standards are still attained. When a demonstration of

nonpoint source reasonable assurance does not exist, or it is determined that nonpoint source pollutant reduction plans, controls or BMPs are not feasible, durable, or will not result in the required load reductions, allocation of greater pollutant loading to point sources cannot occur.

A variety of grants and loans may be available to assist watershed stakeholders with developing and implementing watershed plans, controls and practices to meet the required wasteload and load allocations in the TMDL and demonstrate additional reasonable assurance.

13. Public Participation

EPA regulations require that TMDLs be subject to public review (40 CFR 130.7). The water quality-limited segment of Fishpot Creek in St. Louis County is included on Missouri's EPA-approved 2012 303(d) List of impaired waters. This TMDL was placed on public notice for a 45-day public comment period from June 29, 2012 to Aug. 13, 2012. Any comments received and the department's responses to those comments will be maintained on file with the department and on the Fishpot Creek TMDL record webpage at dnr.mo.gov/env/wpp/tmdl/2186-fishpot-ck-record.htm. In addition to this public notice and comment period, the department hosted a meeting to provide information to the public regarding the TMDL process and the overall goals of this and other bacteria TMDLs developed for impaired streams in St. Louis County. The public meeting was held on Sept. 12, 2012 from 6 pm to 8 pm at the Daniel Boone Branch of the St. Louis County Library at 300 Clarkson Road in Ellisville. The meeting agenda, the department's presentation, and an attendance sheet are available online on the Fishpot Creek TMDL record webpage.

Due to comments received during the 2012 public comment period and revisions made to the state's water quality standards in 2014, changes to the TMDL were necessary. For this reason, a second public comment period was held from May 23, 2014 to Aug. 21, 2014. Groups that directly received the public notice announcement include the Missouri Clean Water Commission, the Missouri Water Quality Coordinating Committee, the Missouri Department of Conservation, the Missouri Department of Transportation, the St. Louis County Soil and Water Conservation District, St. Louis County Department of Health, St. Louis County Public Works, the University of Missouri Extension, the Greenway Network Inc., the Missouri Coalition for the Environment, the St. Louis County Council, the Metropolitan St. Louis Sewer District, Stream Team volunteers living in or near the watershed, the Missouri Stream Team Watershed Coalition, any affected permitted entities, the state legislators representing areas within the watershed and any other individual or group who submitted comments during the first public comment period in 2012. For both public comment periods, the department posted the notice, the water body TMDL information sheets and this TMDL document on the department website, making them available to anyone with access to the Internet. Announcements of these public notice periods were also issued through a press release.

14. Administrative Record and Supporting Documentation

An administrative record on the Fishpot Creek TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources. It includes any studies, data and calculations on which the TMDL is based. This information is available upon request to the department at dnr.mo.gov/sunshine-form.htm. Any request for information on this TMDL will be processed in accordance with Missouri's Sunshine Law (Chapter 610, RSMO) and the department's administrative policies and procedures governing Sunshine Law requests. For more information on

open record/Sunshine requests, please consult the department's website at dnr.mo.gov/sunshinerequests.htm.

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Appendix A

Fishpot Creek *E. coli* data

Sampling Organization[18]	*Site Code*[19]	*UTM Easting*	*UTM Northing*	*Sampling Date*	*Recreational Season?*	*E. coli*[20] *(#/100ml)*	*Flow*[21] *(cfs)*
USGS	2186/1.7	716860	4269989	7/31/1996	Yes	82	0.1
USGS	2186/1.7	716860	4269989	9/23/1996	Yes	110,000	675.0
USGS	2186/1.7	716860	4269989	12/12/1996	No	84	0.4
USGS	2186/1.7	716860	4269989	3/6/1997	No	29	1.1
USGS	2186/1.7	716860	4269989	5/26/1997	Yes	14,000	52.0
USGS	2186/1.7	716860	4269989	6/9/1997	Yes	150	0.0
USGS	2186/1.7	716860	4269989	8/27/1997	Yes	6,500	0.0
USGS	2186/1.7	716860	4269989	10/24/1997	Yes	4,700	2.4
USGS	2186/1.7	716860	4269989	12/17/1997	No	10	0.3
USGS	2186/1.7	716860	4269989	2/24/1998	No	4	1.0
USGS	2186/1.7	716860	4269989	4/3/1998	Yes	14,000	93.0
USGS	2186/1.7	716860	4269989	6/24/1998	Yes	850	1.2
USGS	2186/1.7	716860	4269989	12/1/1998	No	210	0.4
USGS	2186/1.7	716860	4269989	1/31/1999	No	12,000	553.0
USGS	2186/1.7	716860	4269989	2/11/1999	No	44	1.9
USGS	2186/1.7	716860	4269989	5/4/1999	Yes	20,000	122.0
USGS	2186/1.7	716860	4269989	6/16/1999	Yes	94	0.1
USGS	2186/1.7	716860	4269989	8/2/1999	Yes	24	0.1
USGS	2186/1.7	716860	4269989	1/5/2000	No	180	0.3
USGS	2186/1.7	716860	4269989	2/18/2000	No	12,000	237.0
USGS	2186/1.7	716860	4269989	2/28/2000	No	2	0.3
USGS	2186/1.7	716860	4269989	5/7/2000	Yes	62,000	538.0
USGS	2186/1.7	716860	4269989	6/14/2000	Yes	220	0.0
USGS	2186/1.7	716860	4269989	7/31/2000	Yes	200	0.8
USGS	2186/1.7	716860	4269989	12/18/2000	No	11	0.3
USGS	2186/1.7	716860	4269989	2/9/2001	No	3,700	119.0
USGS	2186/1.7	716860	4269989	2/27/2001	No	50	0.6
USGS	2186/1.7	716860	4269989	2/27/2001	No	50	0.6
USGS	2186/1.7	716860	4269989	4/9/2001	Yes	66,000	1,960.0
USGS	2186/1.7	716860	4269989	5/30/2001	Yes	220	0.0
USGS	2186/1.7	716860	4269989	8/28/2001	Yes	73	0.0
USGS	2186/1.7	716860	4269989	10/10/2001	Yes	40,000	808.0
USGS	2186/1.7	716860	4269989	12/11/2001	No	20	0.1
USGS	2186/1.7	716860	4269989	2/5/2002	No	5	0.8
USGS	2186/1.7	716860	4269989	3/9/2002	No	4,800	89.0
USGS	2186/1.7	716860	4269989	5/29/2002	Yes	25	0.3
USGS	2186/1.7	716860	4269989	8/6/2002	Yes	7	0.0
USGS	2186/1.7	716860	4269989	10/25/2002	Yes	6,000	6.1
USGS	2186/1.7	716860	4269989	12/16/2002	No	1	0.0
USGS	2186/1.7	716860	4269989	2/4/2003	No	<1	0.0
USGS	2186/1.7	716860	4269989	3/19/2003	No	5,200	54.0

[18] USGS = U.S. Geological Survey; MSD = Metropolitan St. Louis Sewer District;
[19] See Figure 1 in Section 2 for sample site locations.
[20] For TMDL calculation purposes, less-than (<) values were halved.
[21] cfs = cubic feet per second

Sampling Organization[18]	***Site Code***[19]	***UTM Easting***	***UTM Northing***	***Sampling Date***	***Recreational Season?***	***E. coli***[20] ***(#/100ml)***	***Flow***[21] ***(cfs)***
USGS	2186/1.7	716860	4269989	5/25/2003	Yes	42	0.1
USGS	2186/1.7	716860	4269989	8/12/2003	Yes	28	0.0
USGS	2186/1.7	716860	4269989	10/9/2003	Yes	31,000	6.5
USGS	2186/1.7	716860	4269989	12/15/2003	No	6	0.3
USGS	2186/1.7	716860	4269989	2/10/2004	No	7	0.2
USGS	2186/1.7	716860	4269989	3/4/2004	No	3,600	41.0
USGS	2186/1.7	716860	4269989	6/1/2004	Yes	33	2.3
USGS	2186/1.7	716860	4269989	8/3/2004	Yes	240	0.4
MSD	2186/0.6	717894	4270001	7/27/2005	Yes	100	0.1
MSD	2186/0.6	717894	4270001	8/30/2005	Yes	<100	0.3
MSD	2186/0.6	717894	4270001	10/26/2005	Yes	<100	0.2
MSD	2186/0.6	717894	4270001	11/28/2005	No	1,100	510.0
MSD	2186/0.6	717894	4270001	12/13/2005	No	<100	0.0
MSD	2186/0.6	717894	4270001	3/6/2006	No	<100	0.1
MSD	2186/0.6	717894	4270001	8/1/2006	Yes	<100	0.0
MSD	2186/0.6	717894	4270001	8/14/2006	Yes	270	0.0
MSD	2186/0.6	717894	4270001	10/3/2006	Yes	<100	0.0
MSD	2186/0.6	717894	4270001	10/30/2006	Yes	<100	0.4
MSD	2186/0.6	717894	4270001	11/27/2006	No	<100	0.1
MSD	2186/0.6	717894	4270001	4/2/2007	Yes	940	1.4
MSD	2186/0.6	717894	4270001	4/25/2007	Yes	4,600	11.0
MSD	2186/0.6	717894	4270001	7/31/2007	Yes	140	0.0
MSD	2186/0.6	717894	4270001	9/4/2007	Yes	50	0.0
MSD	2186/0.6	717894	4270001	9/26/2007	Yes	45	0.0
MSD	2186/0.6	717894	4270001	10/16/2007	Yes	200	0.0
MSD	2186/0.6	717894	4270001	10/31/2007	Yes	9	0.0
MSD	2186/0.6	717894	4270001	4/23/2008	Yes	27	0.1
MSD	2186/0.6	717894	4270001	6/18/2008	Yes	50	0.0
MSD	2186/0.6	717894	4270001	6/25/2008	Yes	230	0.0
MSD	2186/0.6	717894	4270001	7/9/2008	Yes	200	0.6
MSD	2186/0.6	717894	4270001	8/13/2008	Yes	64	0.0
MSD	2186/0.6	717894	4270001	10/22/2008	Yes	160	0.0
MSD	2186/0.6	717894	4270001	4/28/2009	Yes	2,480	0.1
MSD	2186/0.6	717894	4270001	5/19/2009	Yes	315	0.2
MSD	2186/0.6	717894	4270001	5/26/2009	Yes	14,100	13.0
MSD	2186/0.6	717894	4270001	7/29/2009	Yes	712	0.0
MSD	2186/0.6	717894	4270001	8/25/2009	Yes	285	0.0
MSD	2186/0.6	717894	4270001	9/16/2009	Yes	327	0.0
MSD	2186/0.6	717894	4270001	10/6/2009	Yes	4,610	15.0
MSD	2186/0.6	717894	4270001	4/6/2010	Yes	910	0.4
MSD	2186/0.6	717894	4270001	4/13/2010	Yes	52	0.0
MSD	2186/0.6	717894	4270001	4/26/2010	Yes	1,090	2.5
MSD	2186/0.6	717894	4270001	7/7/2010	Yes	464	0.0

Appendix B

Development of bacteria load duration curves

B. 1 Overview

The load duration curve approach was used to develop a TMDL for the drainage area of Fishpot Creek. The flow duration curve for this stream was developed using area corrected flow from flow gage data from Fishpot Creek. The load duration curve method allows for characterizing water quality concentrations (or water quality data) at different flow regimes and estimating load allocations and wasteload allocations for an impaired segment. The method provides a visual display of the relationship between stream flow and loading capacity. Using the duration curve framework, allowable loadings are easily presented.

B. 2 Methodology

Using a load duration curve method requires a long time series of flow data, numeric water quality targets, and bacteria data from the impaired streams. Bacteria data, along with the flow measurements for the same date, are plotted along with the load duration curve to assess when the water quality target is exceeded.

A long record of average daily flow data from a gage or multiple gages that are representative of the impaired reach are used to develop the load duration curve. Therefore, the flow record should be of sufficient length to be able to calculate percentiles of flow (typically 10 to 20 years or more). If a flow record for an impaired stream is not available, then a synthetic flow record is needed. For this TMDL, flow gage data from Fishpot Creek was used, USGS 07019120 Fishpot Creek at Valley Park, Mo. This gage had an approved daily flow record from July 18, 1996 to May 2, 2011. Data from this gage were corrected for the drainage area of the impaired segment (Table B.1). From this flow record, a flow duration curve was developed (Figures B.1).

Table B.1. Drainage areas of gage and impaired watersheds and correction factors

Location:	USGS 07019120	WBID 2186
Drainage Area (sq. miles):	9.58	10.73
Correction Factor:	--	1.120042

The selected TMDL target is multiplied by the flow and a conversion factor to generate the allowable load at different flows. With this load duration curve, the targeted concentration is constant at all flow percentiles. The target concentration used to develop the load duration curve for WBID 2186 is the recreation season geometric mean criterion of 206 *E. coli* counts/100 mL applied as a daily target.

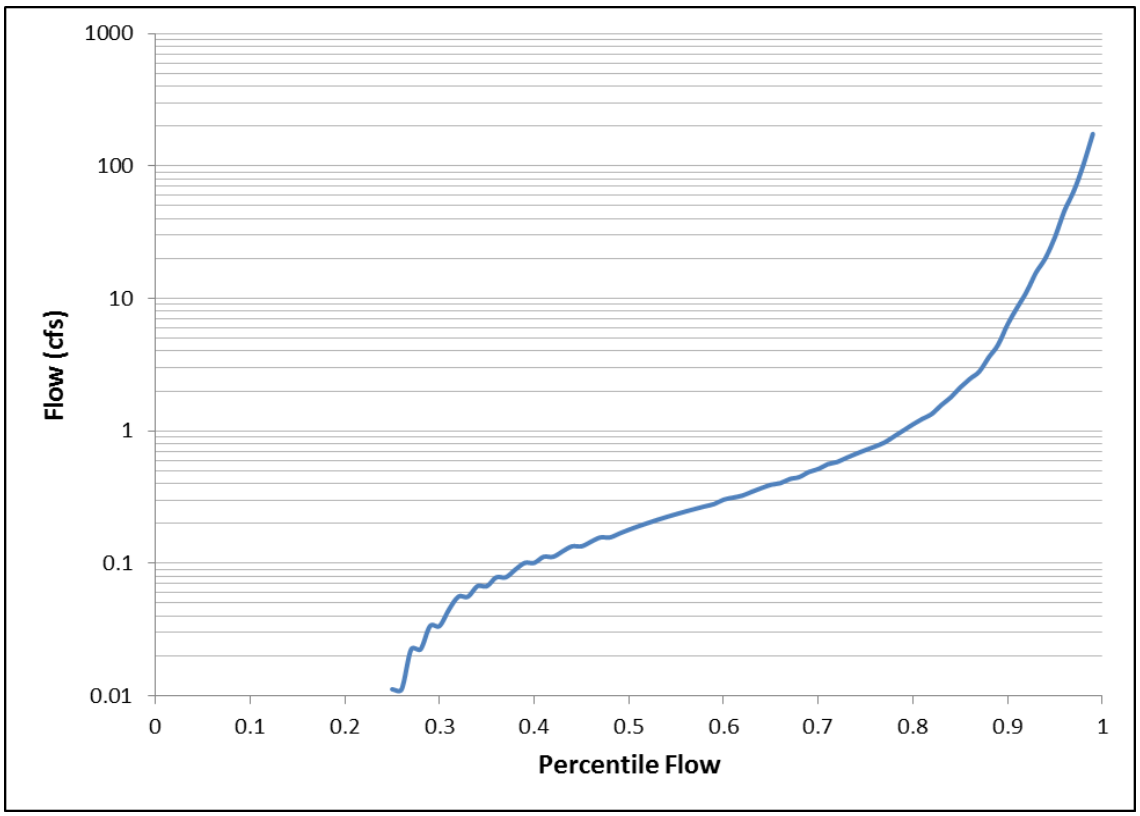

Figure B.1 Flow duration curve for WBID 2186